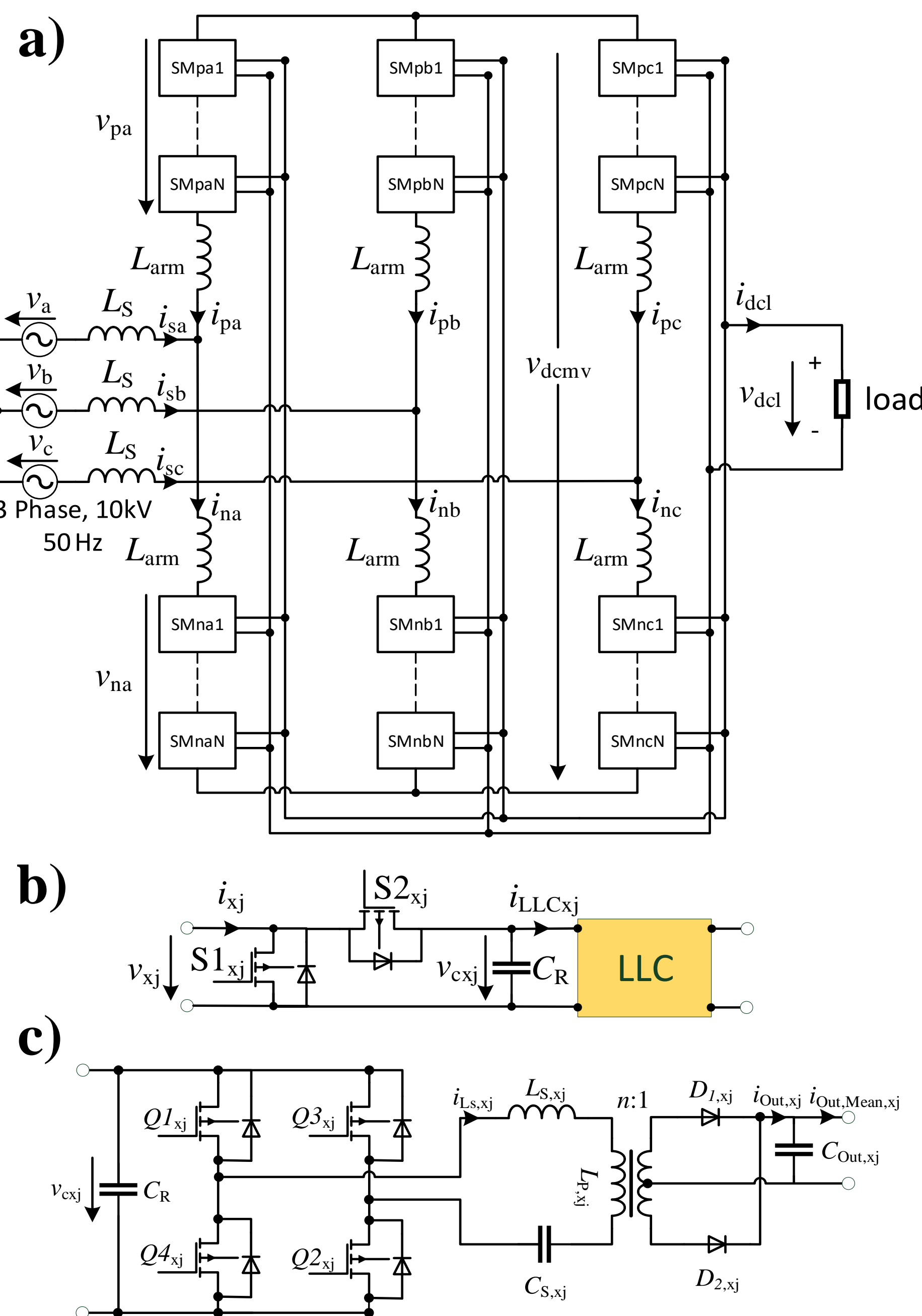


MMC–Topology for High Current and Low Voltage Applications with Minimal Number of Submodules, Reduced Switching and Capacitor Losses

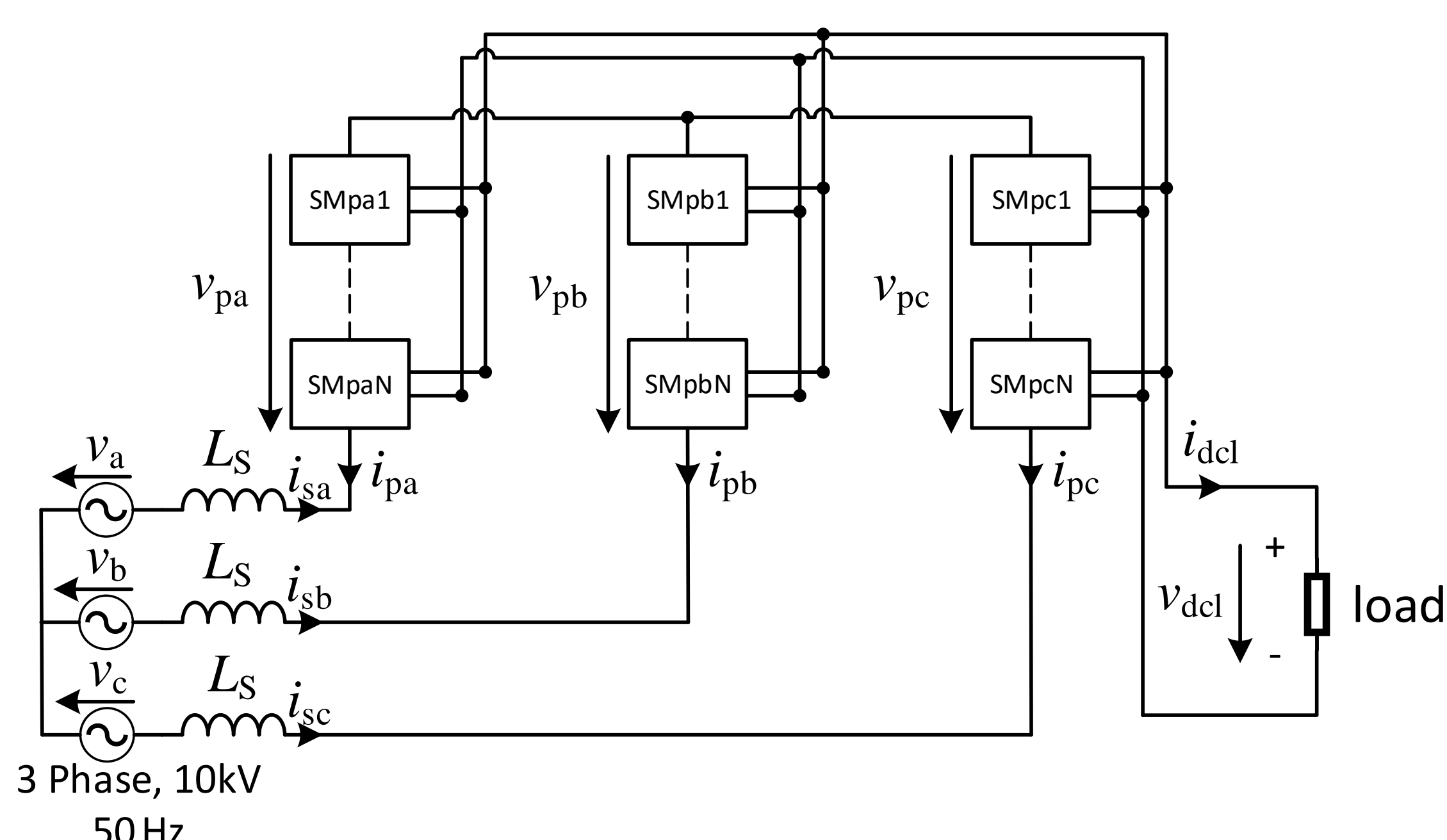
Introduction / Motivation

High Current and Low Voltage Applications

- Electrolysis and plasma arc welding require high currents
- State of the art: large medium voltage transformer
- High THD and low power factor
- YY-MMC with LLC-Converter as submodules**
 - LLCs provide galvanic isolation
 - Load connected to $\hat{v}_{dcl} = 220$ V and $\hat{i}_{dcl} = 4550$ A



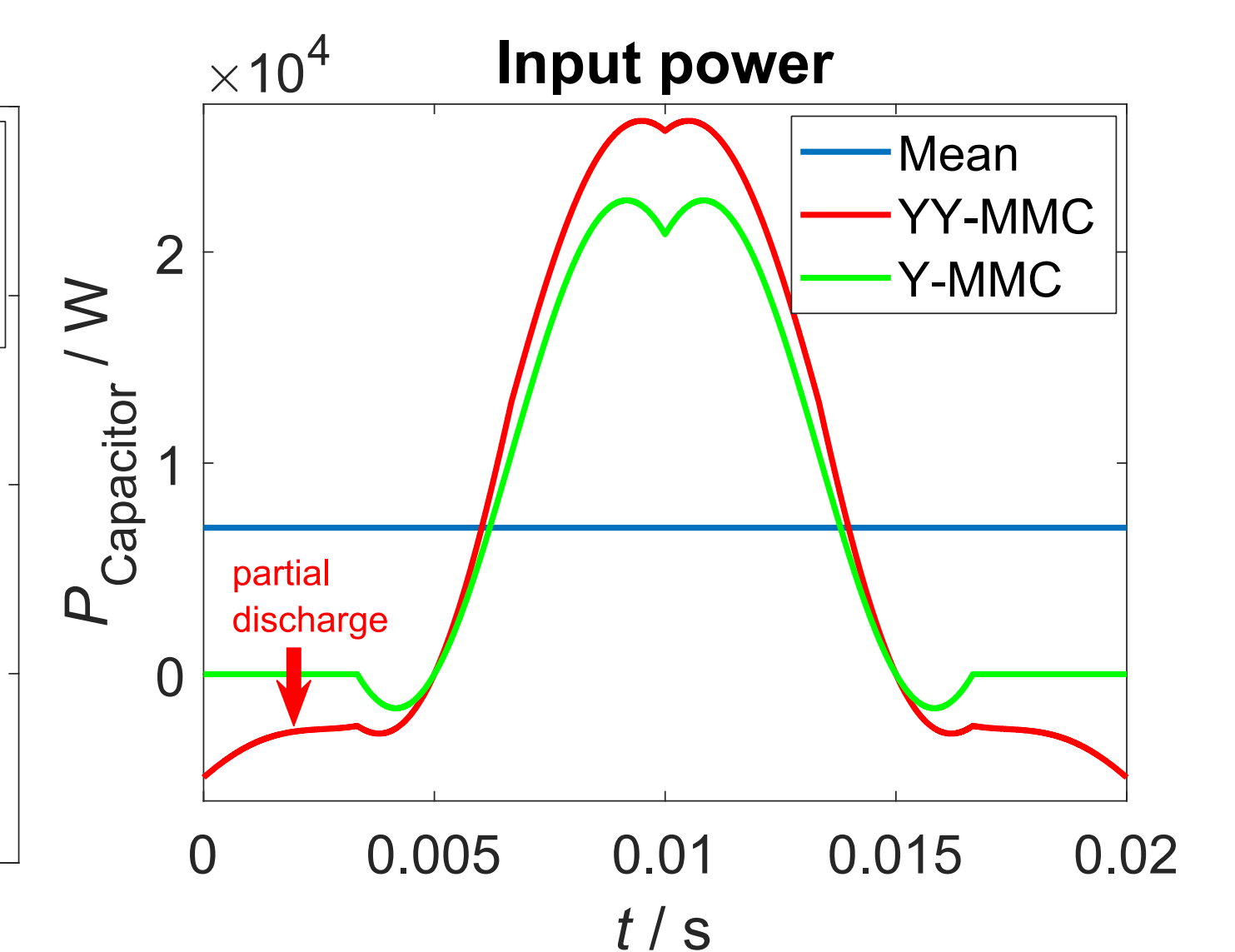
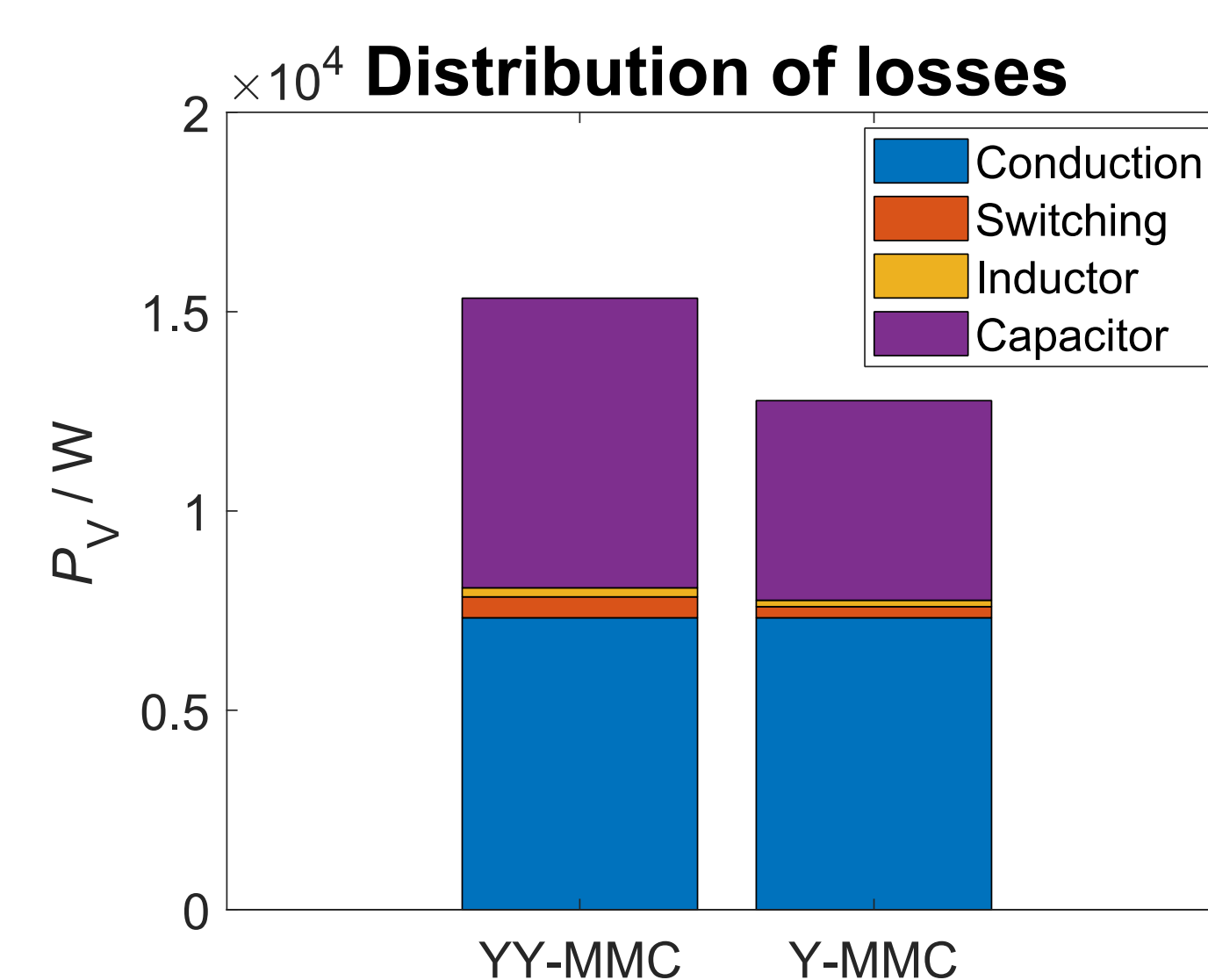
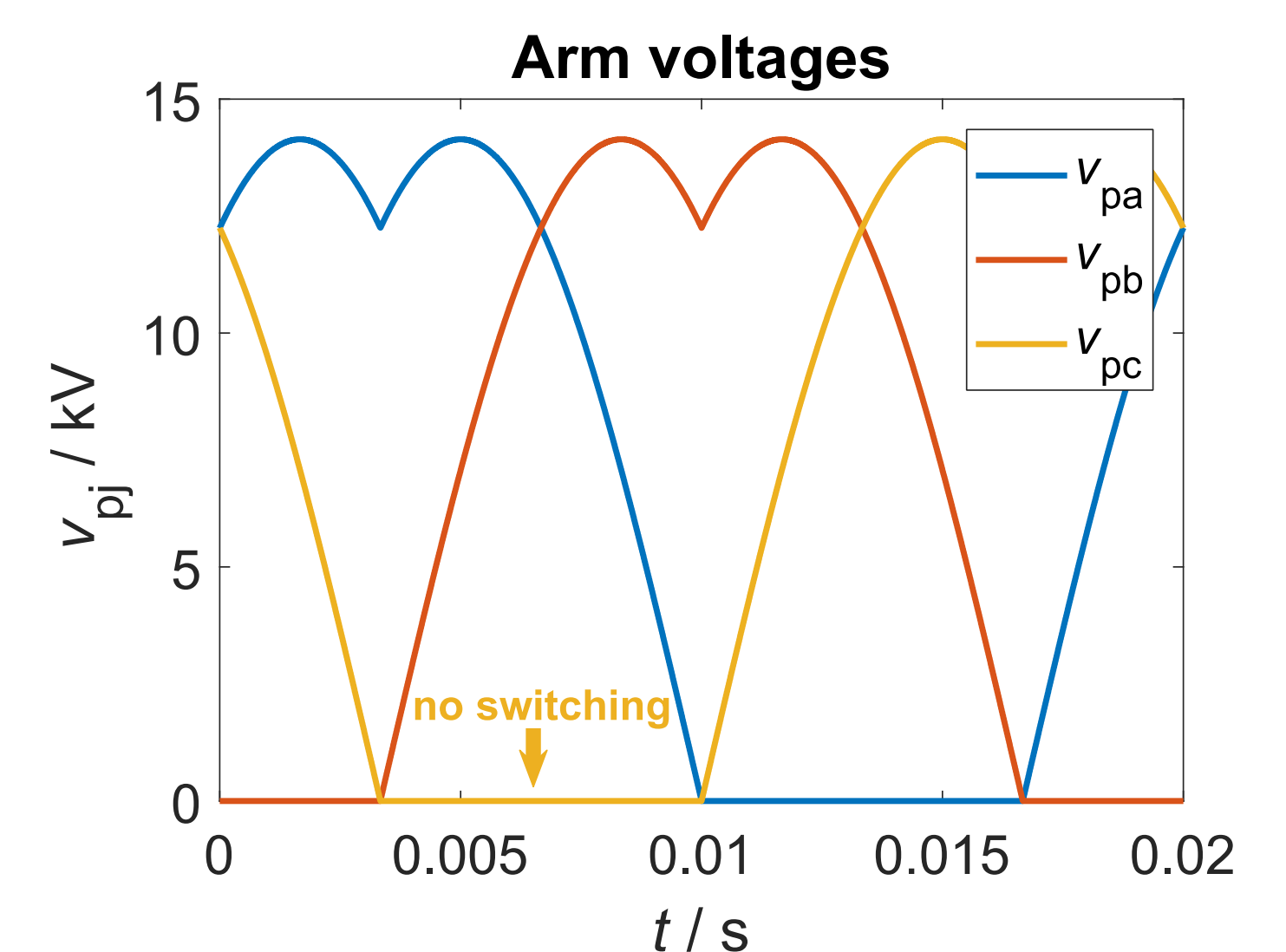
Design Idea



- Medium voltage rail v_{dcmv} not required
- Same functionality with half the number of submodules**
 - 50 % savings in sensors, controllers and communication
 - No arm inductors
 - Larger and more efficient LLCs

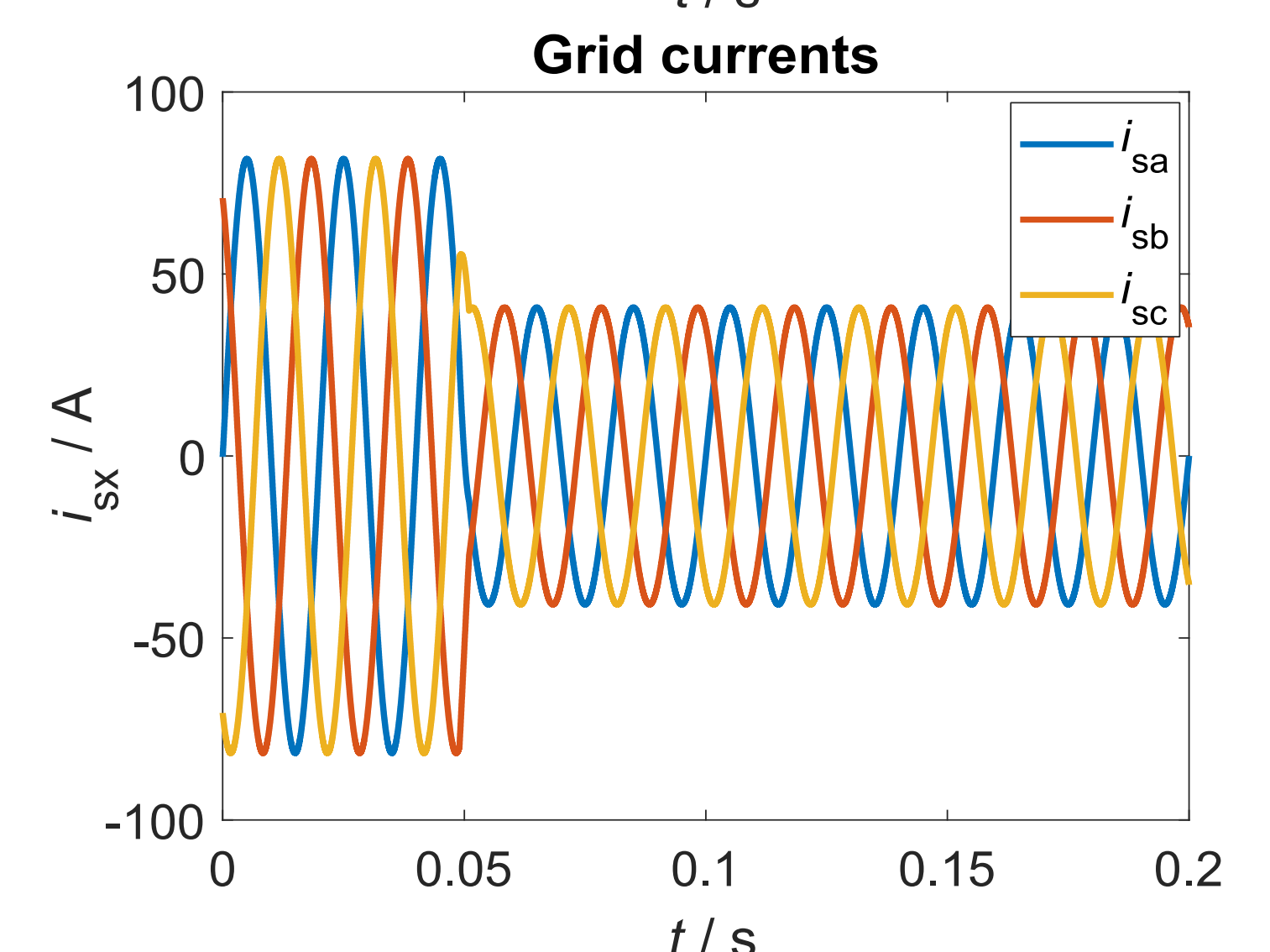
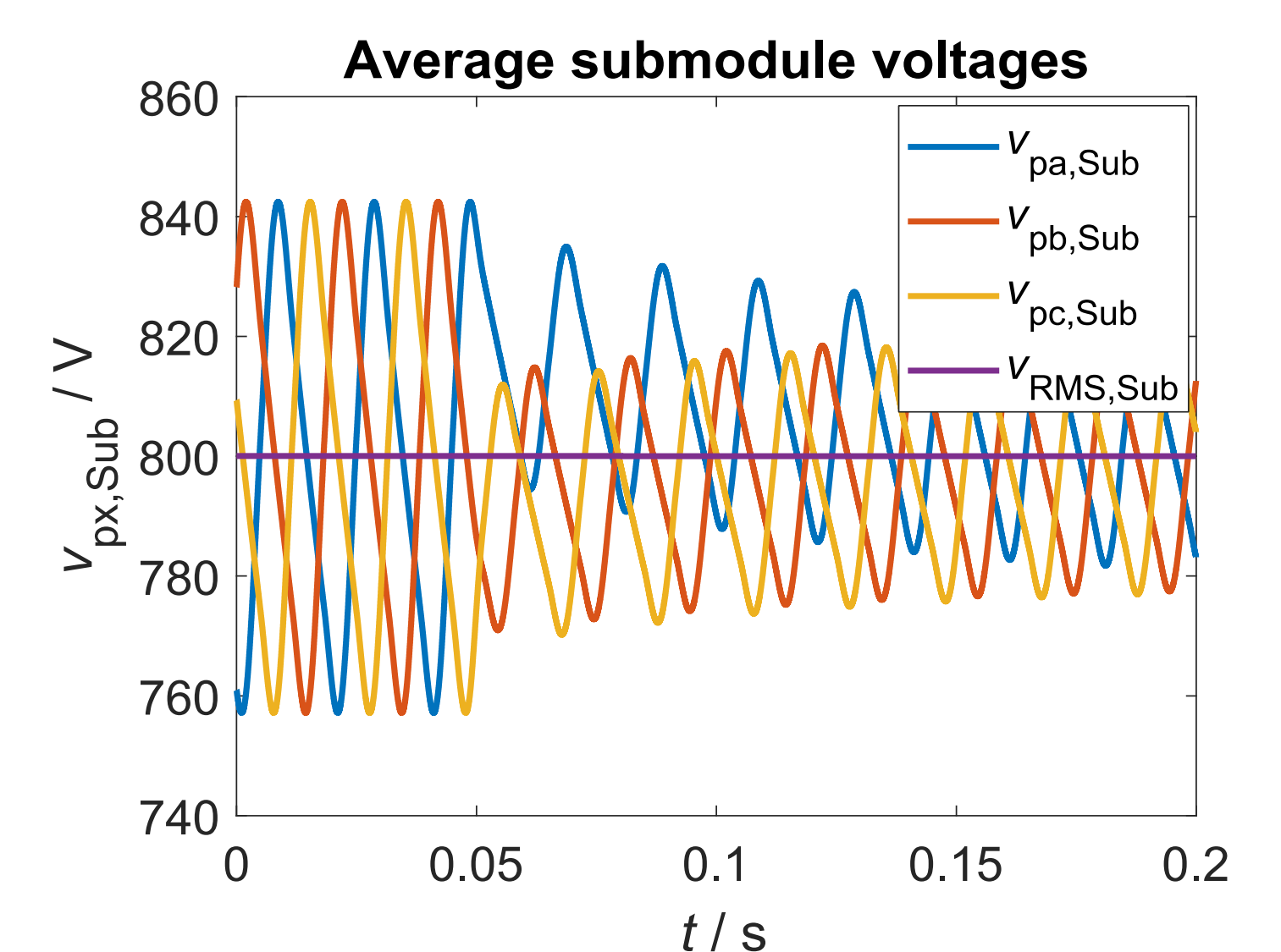
Simulation Results

- Arm voltages control grid currents
- Novel control proposed
- Minimal losses for:
 - $\min(v_{pa}, v_{pb}, v_{pc}) = 0$
 - Reduced power fluctuations
 - Minimal capacitor losses
 - 33 % less switching actions



Voltage Balancing Algorithm

- Transient load: unbalanced voltages
- Goal:
 - Balance submodule voltage
 - Combined output power constant
- Solution:
 - Submodule output power proportional to capacitor energy
 - Local DSP control on each submodule
 - No real time feedback to master processor required



Conclusion

- Largely simplified topology** of Y-MMC
- Half the number of submodules and higher efficiency**
- Voltage Balancing Algorithm is stable and efficient
- Prototype of LLC $\eta_{LLC} = 98.4\%$ at 60 % load
- Overall efficiency similar to transformer based solutions

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